THE additions to the Zoological Society's Gardens during the past week include a Sly Silurus (*Silurus glanis*), European, a Thunder-fish (*Misgurnus fossilis*), a Ground Loach (*Cobitis tænia*) from Danzig; a Barbel (*Barbus vulgaris*), a River Bullhead (*Cottus gobio*) from British fresh waters, presented by Mr. Alban Doran, F.R.C.S.; one hundred Golden Carp (*Carassius auratus*) from Spain, presented by Messrs. Paul and Co.; a Black-shouldered Kite (*Elanus cæruleus*) from Africa, received in exchange.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *DECEMBER* 13-19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 13

Sun rises, 8h. 0m.; souths, 11h. 54m. 33·8s.; sets, 15h. 49m.; decl. on meridian, 23° 12′ S.: Sidereal Time at Sunset, 21h. 19m.

Moon (at First Quarter on Dec. 14) rises, 11h. 48m.; souths, 17h. 16m.; sets, 22h. 53m.; decl. on meridian, 6° 51′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	8 53	12 48	16 43	23 8 S.
Venus	11 4	15 18	19 32	20 5 S.
Mars	23 0*	5 43	12 26	7 52 N.
Jupiter	0 45	6 47	12 49	0 23 S.
Saturn	16 49*	0 58	9 7	22 27 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	μ Piscium	5	1 47	2 40	159 308
18	B.A.C. 741	6½	3 9	3 23	66 34
18	B.A.C. 987	6½	23 2	0 2†	162 284

† Occurs on the following day.

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
13	7 14	I. tr. ing.	16	1 19	I. occ. reap.
14	3 24	I. ecl. disap.	17	7 2	II. ecl. disap.
14	6 51	I. occ. reap.	18	4 36	IV. ecl. disap.
15	1 43	I. tr. ing.	18	7 23	IV. ecl. reap.
15	2 29	III. occ. reap.	19	4 36	II. tr. ing.
15	3 59	I. tr. egr.	19	7 24	II. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Dec.	h.	
17	7	Mercury at least distance from the Sun.
19	4	Mercury in inferior conjunction with the Sun.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′		d.	h. m.	
R Vulpeculæ	20 59 17	23 22·0 N.	Dec.	15,		*m*
δ Cephei	22 24 54	57 49·6 N.	,,	16,	4	*M*
			,,	17,	18	*m*
R Cassiopeiæ	23 52 34	50 44·9 N.	,,	15,		*m*
U Cephei	0 52 8	81 15·3 N.	,,	14,	2 26	*m*
			,,	19,	2 5	*m*
T Monocerotis	6 19 1	7 8·9 N.	,,	17,	22	*M*
ζ Geminorum	6 57 17	20 44·3 N.	,,	18,	17	*m*
U Monocerotis	7 25 19	9 32·2 S.	,,	17,		*M*
T Geminorum	7 42 24	24 1·2 N.	,,	17,		*M*
W Virginis	13 20 6	2 46·9 S.	,,	18,	2	*m*
δ Libræ	14 54 50	8 3·7 S.	,,	15,	19 31	*m*
			,,	18,	3 22	*m*
U Coronæ	15 13 30	32 4·1 N.	,,	19,	21 25	*m*

M signifies maximum; *m* minimum.

Meteor Showers

A shower from the constellation of the Quadrant, radiant, R.A. 220°, Decl. 53° N., may be looked for throughout the week, after the moon has set.

A small shower with radiant in the constellation of the Lynx, R.A. 108°, Decl. 63° N., has been observed by Schmidt and Zezioli during this week of the year.

Stars with Remarkable Spectra

V Cygni R.A. 20h. 37m. 36s., Decl. 47° 43′·8 N., variable. Secchi's fourth type. The blue end is either wanting or extremely faint. The two dark bands usually seen in the orange in stars of this type seem absent, but the dark band in the yellow is very pronounced.

	R.A. h. m. s.	Decl. ° ′		
Birmm. 566	20 32 50	17 52·0 N.	Mag. 7·0	Three well-marked examples of the third type
Birmm. 569	20 40 13	17 40·5 N.	Mag. 6·8	
L.L. 40182	20 43 24	0 59·2 S.	Mag. 6·8	
ρ Persei	2 57 48	38 23·8 N.	Variable	Three typical representatives of the third class
α Orionis	5 48 58	7 22·9 N.	Variable	
π Aurigæ	5 51 24	45 55·5 N.	Mag. 4·8	

α Orionis and ρ Persei show many fine metallic lines beside the system of dark bands, shading off towards the red, which forms the characteristic of the third type of stellar spectrum. These brighter stars should be by all means examined with the fainter stars of the same type that the observer may become perfectly familiar with the characters and positions of the principal bands.

The *Dun Echt Circular*, No. 101, issued on December 5, from Lord Crawford's Observatory, says that the announcement has been received by Harvard College Observatory, from Dr. Lewis Swift, Director of the Warner Observatory, of the discovery of a comet by Barnard.

1885	Greenwich M.T. h. m.	R.A. h. m.	Decl. ° ′
Dec. 3	15 7.2	4 21·9	N. 4 45

Daily motion 35′ towards the north preceding.

The above message was forwarded by Prof. Krueger, of Kiel.

EXPLOSIONS IN COAL MINES[1]

II.

THE superficial observer, in noting the real progress made during the last few years in the facility and success with which the electric light has been utilised in a remarkable variety of directions, might have been pardonably led to the conclusion that there existed no very great difficulties in the way of at once presenting the miner with an electric light in almost as portable a form as a safety lamp—incomparably safer than the best of these—and capable of affording a much superior light for the entire duration of his longest working hours underground. A little inquiry into the subject demonstrated to the Royal Commission that such a conclusion would be at least very premature, and that, although the subject was one most worthy of patient pursuit, the attainment of really useful results was beset with formidable difficulties. It is one thing to announce in oracular fashion, as the *Times* did, in a leading article last June, "that collieries ought to be lighted in a way to dispense with safety lamps," and "that electricity is the one illuminating medium which can supply the light which miners want, without the flame which endangers them." It is quite another thing to apply the electric light with safety, even along main roadways, in mines in which fire-damp is prevalent. The writer of those lines would have been less confident in his assertions had he sought sufficient information to teach him that the fracture of a glow-lamp, or the rupture of a conducting wire in a mine, might be as much fraught with danger as the injury of a safety lamp or the lighting of a pipe. Had he, moreover, but learned by simple inquiry what progress had been made by patient workers (at the time he was inspired thus to write), towards setting aside those sources of danger and providing the miner with a portable and efficient self-contained lamp, he would certainly have hesitated to assert that "no proper zeal has been brought to bear upon the conquest of difficulties" in the application of electric lighting in mines, or to sneer at "the scientific brains, whom the public may encourage, though it cannot compel, to exert themselves as keenly for the illumination of a murky, dirty coal-pit, as in the transformation of a plot of ground in South Kensington into fairyland."

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[1] Address of Sir Frederick Abel, Chairman of Council of the Society of Arts, delivered at the opening meeting, Nov. 18, 1885.—(Abstract by the Author.) Continued from p. 112.

Attempts have been made in several of the mining districts to apply electricity to underground illumination; so far as distribution of the light in main roads is concerned, no great progress has been made, though there is now no reason why glow-lamps, protected after the manner in use at our Government Gunpowder Works (as shown in the recent Exhibition), should not be distributed to considerable distances along such portions of a mine. At Risca Colliery, in Monmouthshire, at Harris's Navigation Colliery, near Pontypridd, and at Earnock Colliery, at Hamilton, N.B., a commencement has already been made in this direction with satisfactory results. If, however, the miner is to have an electric lamp for lighting up drifts and working places, it must be supplied to him in a self-contained and really portable form, with absolute isolation of the glow-lamp from the surrounding atmosphere, and with a store of power sufficient to maintain an efficient light for ten or twelve hours.

The considerable improvements which have of late been effected in accumulators, and the advance which has also been made in the construction of constant primary batteries, have led to very important progress toward the attainment of these essentials. Mr. J. Wilson Swan, universally celebrated for his achievements in the matter of glow-lamps, has patiently pursued the subject, and has not long since succeeded in producing a lamp which, with its small storage battery, weighs little more than 8 lb., and which will furnish a light equal to from two to four times that given by the better forms of safety lamp for a duration of ten or twelve hours. Mr. Swan is sanguine that he will ere long be able to effect an important reduction in the weight and bulk of the lamp, and he is not less hopeful of elaborating a primary battery similar in portability and light-giving power, the substitution of which, if successful, for the accumulator would have the advantage of dispensing with the necessity for providing dynamo-electric machines and power for charging the storage cells. Other workers besides Mr. Swan, such as Mr. Coad and M. Trouvé, have been applying small primary batteries to the production of miners' lamps with some promise of success, although as yet the results furnished do not bear comparison with those obtained by Mr. Swan with the storage battery. Those who have spent any length of time under ground, especially in the very low workings which abound in coal mines, and at the high temperature which often prevails in the workings of deep mines, will have experienced the fact that any incumbrance may sometimes become very burdensome, and can well understand, therefore, that the weight and size of even the lightest form of battery with which an efficient light could be maintained for a sufficient length of time, may prove grave obstacles to its extensive employment. Moreover, as the electric light can afford no indication of the condition of the atmosphere in a mine-working, its employment may not allow of the safety lamp or some other testing appliance being dispensed with. But, even if used only as an auxiliary means of illumination in working places, such lights as those which Swan and others will supply, will prove very valuable, and especially so for exploring purposes, after accidents due to outbursts of gas, when the best safety lamps may be of little use, even if they continue to burn. Such electric lamps must indeed become formidable competitors of the Fleuss lamp (included in the recent Exhibition), which has, in conjunction with the portable apparatus for the supply of respirable air to explorers, already performed important service in rendering access to mine-workings possible where an ordinary lamp could not burn, and where the atmosphere was too foul to support life for any time.

The sudden escape into a mine-working of a very large volume of fire-damp, the accumulating pressure of which has at length overcome the resistance opposed to it, either by the coal or by the stone which forms the floor or the roof of the mine, and the outrush of which is sometimes accompanied by the ejection of very large quantities of disintegrated mineral, constitutes the most formidable danger connected with this associate of coal, because little or no warning is received of its occurrence, and because the volume of gas suddenly liberated is often so considerable that the most powerful ventilating currents are for a time inoperative, while their very action may be to distribute gas rapidly in the form of an explosive mixture with air, to distant parts of the mine-workings. The volume of gas suddenly set free varies very greatly: sometimes it is so considerable that, even with very powerful ventilation, the workings have not been restored to a safe condition for work, in regard to comparative freedom from fire-damp, until several days after the occurrence of the outburst.

That these sudden emissions of gas have been intimately connected with some of the most appalling disasters which have occurred in coal mines appears beyond question, and there is equally little room for doubt that the firing of shots, or use of gunpowder for blasting coal or stones in mines, has been, in many cases, intimately connected with those disasters.

The occurrence of a sudden outburst of gas is, however, not essential to the production of disastrous results by the firing of powder or other explosives in coal mines. The flame developed by the firing of a powder-shot may, without any favouring circumstances, be projected to a considerable distance beyond the face of the coal or stone in which it is fired, if, as is frequently the case, the force is insufficient to accomplish the fracture of the bore-hole in which the charge of explosive is confined, and the highly heated products of the explosion are entirely projected from the hole, as if the shot had been fired from a gun. Experiments upon an extensive scale made, on this head, by the Commission, have shown that the flame from a so-called *blown-out* shot may be projected to distances of thirty or thirty-five feet, in galleries similar to mine-workings or drifts, and if, as is frequently the case, the small debris of coal, which lies ready to hand in the working places is used to tamp the charge with, the volume of flame from a blown-out powder-shot is very greatly increased in length and volume, and may therefore easily extend to goaves, old working places, or cavities where a fire-damp- and air-mixture may be lurking. This is, however, by no means the only, or even the most prominent, danger which may attend the occurrence of a blown-out shot in even the best ventilated coal mine, quite independently of the possibility of a sudden release of a considerable volume of fire-damp during, and consequent upon, blasting. But before referring to what now appears to be well established as the chief general source of danger attending the use of explosives in coal mines, I must touch briefly upon the means available for searching for fire-damp, and for inspecting the workings of a mine, to ascertain that all is safe before men descend to work, or before shots are fired.

The first effect of introducing a Davy or other safety lamp into an atmosphere containing small proportions of fire-damp is to cause the flame to elongate, the extremity becoming narrow and more pointed as the proportion of fire-damp increases; when the latter approaches a porportion which produces with air an inflammable, and ultimately an explosive, mixture, a pale blue halo or cap is perceptible over the flame, and this increases with an increase in the proportion of gas, until the cage or gauze of the lamp is filled with flame. A Davy lamp of small proportions is generally preferred by the overmen or inspectors for gas-testing purposes; the flame is always reduced to small dimensions, so that slight alterations in size or form may be more readily observed. An experienced operator may identify so large a quantity as 2 per cent. of gas in the air of a mine, but even this is very doubtful, except in the case of exceedingly expert observers, who may perhaps succeed in thus detecting the presence of 1·5 per cent. of fire-damp.

It has, however, now been conclusively demonstrated to be of the greatest importance that responsible persons in coal mines should be furnished with reliable means for expeditiously detecting, without the exercise of any very special skill, smaller quantities of fire-damp than it is possible to identify with certainty, even by the exercise of great skill in the use of a safety lamp. Hence much interest and moment attach to the efforts which have been made from time to time by scientific men to devise sensitive and reliable fire-damp indicators. The late Mr. Ansell applied in several very ingenious ways some results of Prof. Graham's classical researches on the diffusion of gases to the construction of sensitive fire-damp detectors, which, however, did not justify the confidence at first placed in them. The same principles have since been applied, but apparently with no greater success, by several foreign inventors of so-called *Grisoumètres*. The late Dr. Angus Smith and Prof. George Forbes have proposed to detect and estimate the quantity of fire-damp in the air of a mine by ingenious applications of other important principles in physical science, and the acoustic indicator, lately exhibited by Mr. Blaikley, is a very pretty application of the principle utilised in a different way by Prof. Forbes. Various forms of eudiometrical apparatus have been constructed with the same object: the variations in the density of air due to the presence of different proportions of fire-damp have been made the basis of other gas-indicating apparatus; a test-lamp has been constructed to furnish a flame when burning alcohol, which is much more sensitive than the oil flame of an ordinary safety lamp; and an electro-photometric test apparatus has been devised by Mr. E. H. Liveing, which appears to have been the most thoroughly practical form of gas-indicator shown at the recent Exhibition.

The importance of being able to recognise very small proportions of fire-damp in air has become specially evident, since the fact has become thoroughly established, by recent careful and comprehensive investigation, that when fire-damp is present in the atmosphere of a mine, in proportions greatly below those necessary to produce a feebly explosive, or even barely inflammable mixture, it may yet constitute a most formidable source of danger, by its co-operation with the dust which exists, in more or less abundance, in every mine-working.

The fact that coal-dust adds considerably to the disastrous effects of fire-damp explosions, was noticed already more than 80 years ago; but Faraday and Lyell were the first to demonstrate, forty years ago, how important a part might be played by coal-dust, in aggravating and extending the destructive effects of fire-damp explosions. When investigating a serious explosion which occurred in the Haswell Colliery in 1844, they observed many signs of the coal-dust being partly burned, and partly subjected to a charring or coking action, by the fire-damp explosion. Their lucid published account of the evidence that coal-dust may play an important part in the effects produced by mine-explosions covers much of the ground gone over by recent workers and writers on the subject, and affords a curious illustration of the ease with which the work of the most illustrious men may be overlooked or forgotten, even by those who should be specially interested in informing themselves of the existing state of knowledge on the subject. Thus, several well-known French mining engineers published, many years after Faraday and Lyell's work, observations, as new, which were simply confirmatory of those philosophers' original statements and conclusions.

Messrs. Galloway and Friere Marreco, but especially the former, have added importantly to our knowledge of the probable behaviour of dust in mines on the occasion of explosions. Mr. Galloway, who performed experiments upon a considerably larger scale than had previously been the case, was certainly the first to enunciate the conclusion that a small proportion of fire-damp is essential to impart to a mixture of air and coal-dust the power of propagating flame, though he afterwards concluded that fire-damp is altogether unnecessary for the conveyance of flame, with explosive effects, by a mixture of dry coal-dust and air.

The more recent results of other workers in this direction have, however, conclusively demonstrated that while some very highly inflammable coal-dusts may, when raised and mixed with the air by the force of a blown-out shot, become inflamed, and carry flame to considerable distances, with a rapidity and violence of action similar to that of a fire-damp explosion, the extent to which flame is propagated, by most descriptions of coal-dust, in the complete absence of fire-damp, is very limited.

In a series of experiments which, after the calamitous accident in Seaham Colliery in the autumn of 1880, I was requested by the present Home Secretary to carry out with coal-dusts, it was conclusively established that the proportion of fire-damp required to be present in the air of a mine, to bring dust readily into operation as an explosive agent, when thickly suspended in the air, may be even decidedly below the smallest amount which a practised eye can detect by means of a Davy lamp. Various other points of interest were established by this series of experiments.

The more extensive experiments subsequently made by the Commission, in large mine galleries, demonstrated that with a very highly inflammable dust suspended in the air in which no trace of hydrocarbon gas was present, a blown-out shot could produce ignitions which would extend as far as the mixture of air with sufficient dust to maintain flame extended.

Important experiments upon a very large scale, which have recently been carried out by the Prussian Fire-damp Commission, at Neunkirchen, in the Saarbrücken district (see NATURE, vol. xxxi. p. 12, and vol. xxxii. p. 55), have thoroughly confirmed and also considerably extended these results.

It appears now to be well established that the considerable volume of flame and rush of gas produced by a blown-out shot is indispensable to the attainment with certainty of any of the dangerous effects of coal-dust. Inasmuch, however, as blown-out shot are of very common occurrence in blasting operations, it is evident that in dusty mines there is a frequent liability to the production of a more or less extensive ignition or explosion of coal-dust, at any rate when even only very small proportions of fire-damp exist in the air of the mine. It will be seen, therefore, that it needs not a sudden outburst or accidental liberation of fire-damp in considerable quantities to cause the flame which may be projected into the air by the firing of a powder-shot to bring about extensive explosions, or ignitions, spreading over large areas, and possibly communicating to distant accumulations of explosive mixtures of gas and air in old workings.

These most serious dangers, arising chiefly from the use of powder in coal mines, have received the anxious attention of the Commissioners, who have, in the first place, considered how far it might be practicable to prescribe effectual means for removing or counteracting the elements of danger presented by the existence of dust accumulations in mines where it may be impossible to guard against the distribution of small proportions of fire-damp through the air.

The possible substitution for gunpowder of other explosive agents which may be applicable to the kind of work performed by it in coal-mines, has naturally also received much attention. A reduction in the volume of flame produced by gunpowder when used as a blasting agent has been effected by modifications in its composition, but the best result attained until recently in this direction had not materially reduced the danger of using powder in the ordinary manner. Some promising results are, however, said to have been quite lately attained in Germany with a special powder produced by the original maker of the now celebrated cocoa powder, the publication of which is looked for with much interest.

Special forms of gun-cotton were prepared for use in coal in the early days of the improvements made in its preparation; but the large proportion of the inflammable and poisonous gas, carbonic oxide, which its explosion furnishes, prohibits its employment in this direction, even in the form of preparations coming under the head of *nitrated gun-cotton*, which yields comparatively small proportions of carbonic oxide.

Nitro-glycerine contains actually more oxygen than required for the complete burning of its constituents, carbon and hydrogen, and hence its detonation in the open air is attended only by the appearance of a lightning-like flash of light. When diluted with an inert non-combustible material, as in dynamite, its detonation raises to a high red heat the particles of mineral matter with which it is mixed, many of which are, therefore, projected in a glowing state, like a shower of sparks, if the dynamite be fired in a strong shot-hole. Even with Nobel's blasting gelatine, the latest and most powerful explosive, a blown-out shot may be attended by the projection of some glowing particles, either of the tamping or detached from the blast-hole.

The Commissioners have satisfied themselves by many experiments that an explosive mixture of gas and air may be exploded by the projection into it of such sparks, and that they may even occasionally produce ignition, when projected into air containing only a small proportion of fire-damp, but in which coal-dust is thickly suspended.

The outline which I have given you of the dangers attending the use of explosives in coal mines, and of the apparently unsurmountable difficulties attending any attempts to approach immunity from the two great elements of danger naturally existing in a very large proportion of coal mines, namely, fire-damp and dust, will probably lead you to the conclusion that there is but one effectual method of dealing with the serious question of accidents due to explosions in coal mines, namely, that of enforcing the exclusion of the use of explosives in coal mines.

In the House of Commons debate of June, 1878, Mr. MacDonald, while acknowledging that the provisions of the Coal Mines Regulation Act of 1872, for prevention of accidents through the use of gunpowder in fiery mines, had been productive of great good, insisted that these regulations were insufficient to guard against fire-damp explosions, and referred, in illustration, to the fact that the firing of the shot itself might liberate a large quantity of gas, which no previous inspection would discover. He urged in the strongest terms that, until blasting in any fiery mine were absolutely prohibited, there must be a continual recurrence of terrible disasters; and, in the debate which followed, there was a general consensus of opinion among the speakers most competent, from personal experience, to express a decided view on the subject (such as Mr. Burt, Sir G. Elliot, and the late Mr. Knowles), that blasting should be prohibited, at any rate in fiery mines. It was admitted that the cost of working coal would be much increased by the enforcement of the suggested prohibition, and the majority of competent witnesses examined afterwards by the Royal Commission maintained that the abolition of shot-firing in coal-getting must be attended by very formidable difficulties, and must, in fact, cause the closing of many pits.

I have shown that even the comparatively very small amount of fire-damp which may, at any rate occasionally, pervade the air in portions of mine-workings where thorough ventilation is most effectually provided for, and may escape detection, suffices to determine the production of a disastrous explosion, if, under these circumstances, a blown-out shot occurs where an accumulation of dust exists; and that it is even possible, in the complete absence of fire-damp, for a blown-out shot to give rise to an explosion in a very dusty working or mine, where the coal is of a specially inflammable and sensitive character. Such being the case, the fact cannot be ignored that last year's decision of the late Home Secretary—which raised consternation in many mining districts—to prohibit the firing of shots in any colliery within a period of three months after the existence of gas had been there reported (while the workmen were in any part of the mine), is far from affording the contemplated protection against disaster resulting from the use of explosives *in the ordinary manner*.

This most grave aspect of the question has received the anxious attention of the Commissioners, who would not have considered themselves justified in relinquishing their work until they had practically investigated, as far as in their power, any measure or suggestion appearing to afford promise of aid in furnishing definite replies to the following important questions:—

(*a*) Whether sufficiently efficient substitutes for explosives exist to warrant the assertion that their abolition need not interfere very materially with the reasonably profitable working of collieries;

(*b*) Whether, therefore, it is practicable to limit their use strictly to localities where the absence of every possible risk of explosion can be demonstrated; or

(*c*) Whether any modifications in the ordinary method of using explosives in mines can be so confidently relied upon to guard against, or overcome, certain dangers attendant upon blasting operations in collieries, that it may be practicable to clearly define and lay down certain conditions which will insure the safe use of explosives, either generally, or in all but special cases, which can be precisely defined.

As regards the first question:—The power and efficiency of recently improved mechanical appliances for bringing down coal or for driving headings or crossways, warrant the sanguine expectation that compressed air and even manual power may be, at no distant day, brought to bear so advantageously in mines where fire-damp occurs, as to render it no great hardship to dispense with the use of explosives in some of the work where at present they are considered indispensable.

The considerable and very rapid increase in volume which freshly-burned quicklime sustains when slaked, led, many years ago, to attempts to apply it to the bringing down of coal; but the idea did not assume a really practical form until Messrs. Sebastian Smith and Moore worked out a simple method of applying the lime so as to insure the effective operation of the disruptive force which it is capable of exerting, and to utilise the considerable heat, developed by the union of the lime with water, in the rapid generation and super-heating of steam in somewhat considerable quantity, thus supplementing, in an important manner, the force exerted by the expansion of the lime. The public has been made familiar, in last year's and this year's Exhibitions, with the general nature of Messrs. Smith and Moore's lime cartridges. The Commissioners witnessed their performances at Shipley Collieries soon after their successful elaboration, and the results of subsequent inquiries and experiments have convinced them that, for coal-getting, the lime process can be, to a large extent, substituted for powder, and that its employment, while securing comparative immunity from danger, is unattended by any important practical difficulties.

It has received extensive trial in many of our mining districts, and also on the Continent, and has already taken firm root in some parts of Staffordshire, Yorkshire, and Derbyshire. Its elaborators do not contend that it affords the means of dispensing with the use of explosives, or of specially powerful mechanical appliances, in the removal of stone, or even in some very hard coal; but it is certain that in many collieries, where the prevalence of fire-damp renders the use of the safety lamp imperative, the replacement of shot-firing by lime-cartridges, while unattended by any increase in the cost of getting the coal, would reduce the risk of explosions to those arising from carelessness, or from what should now become the very remote contingency of the use of unsafe or defective lamps.

The idea has been entertained that, by surrounding or covering the charge of powder in a shot-hole with some material which evolves vapour of water, or carbonic acid, when exposed to sufficient heat, these would be liberated by the firing of the shot in sufficient quantity and with sufficient rapidity to extinguish flame and sparks projected by it; but the authors of such suggestions have failed to realise the fact that the exposure of these substances to heat on the firing of a shot would be almost instantaneous, and would therefore leave, at any rate, the greater proportion practically unaltered.

It was suggested by me to the Commissioners that possibly the sudden liberation of carbonic acid, confined in the liquefied state, and placed either over or under the charge in a shot-hole, might prove effective in extinguishing flame and sparks, and a number of experiments have been made in this direction, with considerable, though not complete, success.

Dr. McNab was the first to put into practical execution the idea of using water tamping, in the form of a long cylinder filled with the liquid and placed over the powder charge; with the twofold object of extinguishing the projected flame and sparks, and of diminishing, by dispersion of the water in the immediate vicinity of the shot, the persistence of the powder smoke, which is a source of much inconvenience and loss of time. While it has been demonstrated that decided economy in time does result from the more rapid clearing of the air from smoke when the water tamping is used, many careful experiments conducted for the Commission have shown that no reliance could be placed upon the extinguishing power of water, applied in the way originally suggested by Dr. McNab.

In 1879 I suggested to the Commission a plan by which possibly the more violent explosives, of the dynamite class, might be safely and efficiently applied to the getting of coal, based upon the principle of distributing the force developed by the detonation of small charges over a considerable area through the agency of a column of water, within which the detonated charge was confined. This principle, which has since received important applications in connection with military service, appeared applicable to effect a modification of the shattering action, which renders the violent explosives inapplicable to coal-getting, when used in the ordinary manner, their effects being thus assimilated to those of powder, while the sparks and highly-heated gases projected by a blown-out shot might be effectually quenched by the water which would envelope them at the instant of their projection.

Experiments carried out at Wigan in 1880, demonstrated that the coal brought down by small charges of dynamite inclosed in water compared very favourably with the best results furnished by full powder charges, and these results have been fully confirmed by trials since carried out for the Commission in South Wales. Absolute immunity from danger of the ignition of an explosive gas-mixture by a blown-out shot of dynamite or similar explosive agent was not found to be secured by this system of blasting; such was the case, however, then the blown-out shot was projected into air containing fire-damp in proportions approaching that of an explosive mixture, and in which a very inflammable coal-dust was thickly suspended. It has also been found, in the Commissioners' experiments, that the superposition of the water-tamping, according to Dr. McNab's original plan, over a dynamite charge, appears to afford security against the ignition of a dust-laden mixture of air with a somewhat considerable proportion of gas.

Even while actively engaged in the completion of their Report, the Commissioners are still pursuing this subject experimentally, with the desire of furnishing, as far as in their power, decisive and thoroughly reliable data regarding the amount of security which appears to be afforded, by these methods of working, against the most prominent and prevalent sources of danger in connection with the use of explosives in coal mines; and—while I have been engaged upon this address—a still more simple method of applying water to counteract the dangers arising from blown-out shots has suggested itself to Mr. Galloway,—preliminary experiments with which have furnished most important results.

I have now attempted to give you an outline of the progress made within the last few years towards a thorough comprehension of the nature and causes of those dangers which most prominently direct public attention to the perils of the miner's calling—and of the advances already made, and rapidly progressing, towards the provision of the miner with really safe and efficient underground illumination, with efficient substitutes for explosives for a large proportion of the work connected with coal mining, and with safe methods of using explosive agents where these cannot be dispensed with; so safe that the terrors which have attended blasting in mines may be confidently expected speedily to fade away. I venture to think it will have demonstrated that we have made most satisfactory and important progress in all of these several directions, thanks to the labours of professional associations, of scientific and practical experts, and, I think I may also say, thanks to the exertions of the Royal Commission on Accidents in Mines.

I have been led to refer more fully than I had first intended to the work performed by the Royal Commission—the results of which, in detail, will shortly be in the hands of the public—because I felt sure that the members of the Society of Arts would take a most lively and sympathetic interest in the labours of men, who have not allowed themselves to be discouraged by unjust attacks and ignorant criticism, from endeavouring to carry to a useful termination the arduous work which they cheerfully took upon themselves.

The Commissioners have been silent while hard things have been said of them; but it were idle to deny that they have acutely felt the injustice reflected upon them by some writers in the public Press who, while posing as judges or philanthropists, have not earned for themselves, by knowledge acquired, or by work performed, the right to criticism.

Thirty years' personal experience of the work of experimental Committees has taught me that *ad interim* reports are not unfrequently worse than valueless, and this would certainly have been the case had the Commissioners attempted to make any so-called progress reports, because conclusions, or suggestions, might have been put forward in them which would have had to be afterwards recalled, or incomplete data given, which might have been misleading, and, therefore, even dangerous.

As regards the question of the unsafe nature of certain so-called safety lamps, however, I have pointed out that the Commissioners, just five years ago, reported to the Home Secretary in no hesitating terms, in the belief that their statements would have been published,—and it is no fault of theirs that the public was not informed of their strongly-expressed conclusions on this subject, but has been, on the contrary, recently told in the *Times* by a well-known mining engineer that the results of the Royal Commission's labours "have not even extended to the official condemnation of the known unsafe lamps."

The daily journals have at any rate chronicled the activity of the Commission by recording the dates and *locale* of their frequent meetings,—and have been cognisant, therefore, of the fact that their place of work was easily accessible. This being so, it is somewhat matter for surprise that the writer of very condemnatory paragraphs in an editorial article, suggested by correspondence published in the *Times* last June, should not have cared, in the first instance, to inform himself, however imperfectly, of the kind of work upon which the Commission was engaged, and to take that opportunity of seeking some little correct information on the subjects with which his graphic pen was directed to deal. Had he done so, he would scarcely have instructed the public that "a huge majority of colliery accidents arise from explosions;" that "coal mines generate an explosive gas, which, when collected in a quantity, and exposed to a flame, ignites, and blows into fragments the workings in which the vapour and flame meet;" "that every coal mine has its explosive gas," or that "often the miner has opened the door of his lamp to light up the cavern, already perhaps darkening with the heaviness of a gas-laden atmosphere." I will do him the justice to believe that he would not have felt disposed, after even very brief inquiry, to indorse as "not exaggerated" the declaration of the "strenuous and benevolent correspondent," Mr. Ellis Lever, "that the delay in the issue of the Commission's Report was "to the eternal discredit of Royal Commissions."

After all, however, it rests entirely with the public Press to decide for itself whether the ends it has in view are such as to render it desirable to seek for correct information before administering public condemnation.

But, with a public official, especially when connected with the very Department of State most directly concerned in the work of the Commission, the case is very different; and it is scarcely to be credited that the gentleman intrusted with reporting to the Home Secretary upon the circumstances attending the explosion last summer, at Clifton Hall Colliery, should not have thought it worth his while to ascertain, by inquiry, which could not but have been of immediate service to him, whether the delay in the completion of the Commissioners' Report was "unaccountable."

To this Society, which has always distinguished itself by its encouragement of earnest workers, and by its just judgment of their labours, I have ventured, as one of its members, to make these comments, which could not be uttered by me in my capacity as a member of Her Majesty's Commission, whose duty it is simply to report the results of their labours when they have, to the best of their judgment, fulfilled the duties imposed upon them.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 19.—Abstract of "Report on a Series of Specimens of the Deposits of the Nile Delta, obtained by the recent Boring Operations." By J. W. Judd, F.R.S., Professor of Geology in the Normal School of Science and Royal School of Mines. Communicated by order of the Delta Committee.

Neither of the borings made for the Royal Society, under the superintendence of the engineers attached to the army of occupation in Egypt, appears to have reached the rocky floor of the Nile-Valley, nor do the samples examined show any indication of an approach to such floor. What were at first supposed to be pebbles in one of the samples from Tantah, prove on examination to be calcareous concretions ("race," or "kunkur"). Nevertheless, these borings appear to have reached a greater depth than all previous ones in the same district with one or two exceptions. The deepest of the three borings now reported upon have been carried to 73 and 84 feet respectively.

The samples from these borings, like those examined by Mr. Horner, show that the delta-deposits all consist of admixtures, in various proportions, of blown-sand and alluvial-mud. I can find no evidence to support the suggestion made by Sir J. W. Dawson, F.R.S., from a hasty examination of the specimens, that "at a depth of 30 or 40 feet the alluvial mud rests on desert sand;" on the contrary these borings, like those of older date, show that the deposits of the Nile Valley consist of a succession of different beds in some of which sand, and in others mud, forms the predominant constituent.

The *sands*, when separated from the mud by washing, are found to be made up of two kinds of grains, the larger being perfectly rounded and polished, while the smaller, on the contrary, are often subangular or angular.

The larger and well-rounded grains may be described as microscopic pebbles; their surfaces are most exquisitely smoothed and polished, and their forms are either globular or ellipsoidal. In size they vary greatly, being occasionally as large as a small pea. They only very occasionally exhibit traces of deposits of iron-oxides upon their surfaces.

Embedding these grains in Canada balsam, and examining them by transmitted light, with the aid of the polariscope, we are in nearly all cases enabled to determine their mineral characters. The majority of the grains consist of colourless quartz, though occasionally rose-quartz, amethystine quartz, citrine, and smoky quartz also occur. This quartz exhibits unmistakable evidence of having been derived from granitic rocks; it is constantly seen to be traversed by bands of liquid- and gas-cavities, and very frequently contains numerous black hair-like inclusions (rutile?). Much more rarely we detect grains of quartz which consist of aggregates of small crystals, and are evidently derived from metamorphic rocks. With the pure quartz grains we find also a considerable number of rounded particles of red and brown jasper and of black Lydian stone, with fragments of silicified wood.

But in addition to the different varieties of quartz, particles of felspar are found in considerable abundance among these large rounded grains. What is very remarkable about these felspar-grains is the slight traces of kaolinisation which they exhibit; they are, in fact, almost as fresh and unaltered as the grains of quartz themselves. Ordinary orthoclase and microline are